

IN THE CLAIMS:

Please cancel claims 12 and 25.

Please amend the claims as follows:

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1. A process chamber for processing a substrate in a process gas and reducing emissions of hazardous gas to the environment, the process chamber comprising:
- (a) a support capable of supporting the substrate;
  - (b) a gas distributor capable of introducing process gas into the process chamber;
  - (c) a gas activator capable of activating the process gas to perform a process in the process chamber thereby forming effluent containing hazardous gas;
  - (d) an exhaust tube through which the effluent may be flowed, the exhaust tube [having an internal flow surface that is] being substantially absent projections or recesses that alter the [effluent flow path] flow direction of the effluent through the exhaust tube; and
  - (e) a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent.
2. The process chamber of claim 1 wherein the exhaust tube comprises a length that is sufficiently long to reduce the hazardous gas content of [a continuous stream of] the effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube.

3. The process chamber of claim 1 wherein the exhaust tube comprises a length that is sufficiently long to provide a residence time of the effluent [flowing through the exhaust tube] that is at least about 0.01 seconds.

4. The process chamber of claim 1 wherein the [internal flow surface] exhaust tube is adapted to provide a laminar flow of effluent therethrough [through the exhaust tube].

5. The process chamber of claim 4 wherein the exhaust tube comprises a cylinder [and wherein the internal flow surface is] having an axis parallel to the direction of the flow of the effluent through the exhaust tube.

6. The process chamber of claim 1 further comprising a reagent gas mixer capable of mixing a reagent gas with the effluent [to further reduce the hazardous gas content of the effluent].

7. The process chamber of claim 1 wherein the exhaust tube comprises [monocrystalline] sapphire.

8. The process chamber of claim 1 further comprising an RF energy applicator to couple RF energy to the effluent [in the exhaust tube].

9. The process chamber of claim 1 wherein the exhaust tube comprises a distributor plate at an inlet of the exhaust tube[, the distributor plate having holes adapted to direct effluent preferentially along the internal flow surface of the exhaust tube].

10. A gas treatment apparatus for reducing a hazardous gas content of an effluent from a process chamber, the gas treatment apparatus comprising:

(a) an exhaust tube through which effluent from the process chamber may be flowed;

(b) a microwave energy applicator to couple microwaves to the effluent flowing through the exhaust tube to reduce the hazardous gas content of the effluent;

(c) a gas analyzer capable of monitoring the hazardous gas content of the effluent [in the exhaust tube] and providing [an output] a signal in relation to the hazardous gas content of the effluent; and

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(d) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the [output] signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of the following:

(i) adjusting a power applied to the microwave energy applicator to reduce the hazardous gas content in the effluent,

(ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,

(iii) activating an alarm or metering display,

(iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or

(v) terminating the process being conducted in the process chamber.

11. A process chamber for processing a substrate and reducing emissions of hazardous gas to the environment, the process chamber comprising:
- (a) a support capable of supporting the substrate in the process chamber;
  - (b) a gas distributor capable of introducing process gas into the process chamber;
  - (c) a gas activator capable of activating the process gas to process the substrate, thereby forming an effluent containing hazardous gas; and
  - (d) an exhaust tube through which [a continuous stream of] the effluent may be flowed;
  - (e) a microwave energy applicator to couple microwaves to the effluent [in the exhaust tube] to energize the effluent;
  - (f) a gas analyzer capable of monitoring the hazardous gas content of the effluent in the exhaust tube and providing [an output] a signal in relation to the hazardous gas content of the effluent; and
  - (g) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the [output] signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of the following:
    - (i) adjusting a power applied to the microwave energy applicator to reduce the hazardous gas content in the effluent,
    - (ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,
    - (iii) activating an alarm or metering display,
    - (iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or
    - (v) terminating the process being conducted in the process chamber.

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14. The process chamber of claim 11 further comprising an RF energy applicator to couple RF energy to the effluent [in the exhaust tube].

15. The process chamber of claim 11 wherein the exhaust tube comprises [monocrystalline] sapphire.

24. A process chamber for processing a substrate in a process gas and reducing emissions of hazardous gas to the environment, the process chamber comprising:

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- (a) a support capable of supporting the substrate;
  - (b) a gas distributor capable of introducing process gas into the process chamber;
  - (c) a gas activator capable of activating the process gas to process the substrate thereby forming an effluent containing hazardous gas;
  - (d) an exhaust tube comprising [monocrystalline] sapphire through which the effluent [from the process chamber] may be flowed; and
  - (e) a microwave energy applicator adapted to couple microwaves to the effluent [flowing through the exhaust tube] to reduce the hazardous gas content of the effluent.

26. A process chamber for processing a substrate in a process gas and [while] reducing emissions of a hazardous gas to the environment, the process chamber comprising:

(a) a support capable of supporting the substrate, a gas distributor capable of introducing process gas into the process chamber, and a gas activator capable of activating the process gas to process the substrate, thereby forming an effluent containing hazardous gas;

(b) an exhaust tube capable of exhausting the effluent from the process chamber and a gas energizer adapted to energize the effluent in the exhaust tube to reduce a hazardous gas content of the effluent;

(c) a gas analyzer adapted to monitor the hazardous gas content of the effluent in the exhaust tube and to provide [an output] a signal in relation to the hazardous gas content of the effluent; and

(d) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the [output] signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of:

(i) adjusting a power applied to the gas energizer to reduce the hazardous gas content in the effluent,

(ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,

(iii) activating an alarm or metering display,

(iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or

(v) terminating the process being conducted in the process chamber.

27. The process chamber of claim 26 wherein the computer readable program code on the computer readable medium comprises one or more of:

(1) gas analyzer program code for receiving the [output signals] signal [relating to the hazardous gas content of the effluent] from the gas analyzer, and storing or passing the [output signals] signal to other program codes,

(2) gas energizer program code for adjusting a power level of the microwave applicator in relation to the [output signals] signal,

(3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the [output signals] signal, and

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(4) safety operational program code that upon receiving [an output] a signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas content [emissions], (2) operating an alarm [to indicate a dangerous level of toxic or hazardous gas in the effluent], (3) providing a metering display that shows the level of the [emissions of] hazardous gas content, or (4) shutting down the process chamber.

28. A computer program product for operating a gas treatment apparatus and process chamber, to reduce the hazardous gas content of an effluent formed during processing of a substrate in the process chamber,

the gas treatment apparatus comprising an exhaust tube capable of exhausting effluent from the process chamber, a gas energizer adapted to energize the effluent in the exhaust tube to reduce the hazardous gas content of the effluent, and a gas analyzer adapted to monitor the hazardous gas content of the effluent in the exhaust tube and provide a [an output] signal in relation to the hazardous gas content of the effluent,

the computer program product comprising a computer usable medium having computer readable program code embodied in the medium, the computer readable program code comprising:

(a) gas analyzer program code for receiving the [output] signal [relating to the hazardous gas content of the effluent] from the gas analyzer, and storing or passing the [output] signal to other program codes; and

(b) safety operational program code that upon receiving a [an output] signal that the hazardous gas content of the [energized] effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas content [emissions], (2) operating an alarm [to indicate a dangerous level of toxic or hazardous gas in the effluent], (3) providing a metering display that shows the level of the [emissions of] hazardous gas content, or (4) shutting down the process chamber.

29. The computer program product of claim 28 wherein the computer readable program code comprises program code for adjusting a power level of the microwave energy applicator in relation to the [output] signal to reduce the hazardous gas content [emissions] of the effluent.



30. The computer program product of claim 28 wherein the computer readable program code comprises reagent gas program code for adding reagent gas to the effluent in relation to the [output] signal to reduce the hazardous gas content [emissions] of the effluent.

31. The process chamber of claim 1 wherein the microwave energy applicator comprises a waveguide [for coupling] to couple microwaves to the effluent in the exhaust tube.

33. The process chamber of claim 11 wherein the microwave energy applicator comprises a waveguide [for coupling] to couple microwaves to the effluent in the exhaust tube.

35. The process chamber of claim 24 wherein the microwave energy applicator comprises a waveguide [for coupling] to couple microwaves to the effluent in the exhaust tube.

36. The process chamber of claim [28] 26 wherein the RF energy applicator comprises facing electrodes or an inductor coil.

Please add the following claims:

37. The process chamber of claim 1 further comprising:  
(a) a gas analyzer adapted to monitor the hazardous gas content of the effluent in the exhaust tube and to provide a signal in relation to the hazardous gas content of the effluent; and  
(b) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the signal from the gas analyzer, and

when the hazardous gas content of the effluent exceeds a safety level, performing at least one of:

- (i) adjusting a power applied to the gas energizer to reduce the hazardous gas content in the effluent,
- (ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,
- (iii) activating an alarm or metering display,
- (iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or
- (v) terminating the process being conducted in the process chamber.

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38. The process chamber of claim 37 wherein the computer readable program code on the computer readable medium comprises one or more of:

- (1) gas analyzer program code for receiving the signal from the gas analyzer, and storing or passing the signal to other program codes,
- (2) gas energizer program code for adjusting a power level of the microwave applicator in relation to the signal,
- (3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the signal, and
- (4) safety operational program code that upon receiving a signal that the hazardous gas content of the energized effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas content, (2) operating an alarm, (3) providing a metering display that shows the level of the hazardous gas content, or (4) shutting down the process chamber.

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39. The process chamber of claim 7 wherein the sapphire comprises monocrystalline sapphire. 0

40. The apparatus of claim 10 wherein the exhaust tube is substantially absent projections or recesses that alter the flow direction of the effluent through the exhaust tube.

41. The apparatus of claim 10 wherein the exhaust tube comprises a length that is sufficiently long to reduce the hazardous gas content of the effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube.

42. The apparatus of claim 10 wherein the exhaust tube comprises a length that is sufficiently long to provide a residence time of the effluent that is at least about 0.01 seconds.

43. The apparatus of claim 10 wherein the exhaust tube is adapted to provide a laminar flow of effluent therethrough.

44. The apparatus of claim 43 wherein the exhaust tube comprises a cylinder having an axis parallel to the direction of the flow of the effluent through the exhaust tube.

45. The apparatus of claim 10 further comprising a reagent gas mixer to mix the reagent gas with the effluent.

46. The apparatus of claim 10 wherein the exhaust tube comprises sapphire.

47. The apparatus of claim 46 wherein the sapphire comprises monocrystalline sapphire

48. The apparatus of claim 10 further comprising an RF energy applicator to couple RF energy to the effluent.

49. The apparatus of claim 10 wherein the computer readable program code on the computer readable medium comprises one or more of:

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- (1) gas analyzer program code for receiving the signal from the gas analyzer, and storing or passing the signal to other program codes,
  - (2) gas energizer program code for adjusting a power level of the microwave applicator in relation to the signal,
  - (3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the signal, and
  - (4) safety operational program code that upon receiving a signal that the hazardous gas content of the effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas content, (2) operating an alarm, (3) providing a metering display that shows the level of the hazardous gas content, or (4) shutting down the process chamber.

50. The process chamber of claim 11 wherein the exhaust tube is substantially absent projections or recesses that alter the flow direction of the effluent through the exhaust tube.

51. The process chamber of claim 11 wherein the exhaust tube is adapted to provide a laminar flow of effluent therethrough.

52. The process chamber of claim 51 wherein the exhaust tube comprises a cylinder having an axis parallel to the direction of the flow of the effluent through the exhaust tube.

53. The process chamber of claim 11 further comprising a reagent gas mixer to mix the reagent gas with the effluent.

54. The process chamber of claim 11 wherein the computer readable program code on the computer readable medium comprises one or more of:

(1) gas analyzer program code for receiving the signal from the gas analyzer, and storing or passing the signal to other program codes,

(2) gas energizer program code for adjusting a power level of the microwave applicator in relation to the signal,

(3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the signal, and

(4) safety operational program code that upon receiving a signal that the hazardous gas content of the effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas content, (2) operating an alarm, (3) providing a metering display that shows the level of the hazardous gas content, or (4) shutting down the process chamber.

55. The process chamber of claim 15 wherein the sapphire comprises monocrystalline sapphire.

56. The process chamber of claim 24 wherein the exhaust tube is substantially absent projections or recesses that alter the flow direction of the effluent through the exhaust tube.

57. The process chamber of claim 24 wherein the exhaust tube comprises a length that is sufficiently long to reduce the hazardous gas content of the effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube.

58. The process chamber of claim 24 wherein the exhaust tube comprises a length that is sufficiently long to provide a residence time of the effluent that is at least about 0.01 seconds.

59. The process chamber of claim 24 wherein the exhaust tube is adapted to provide a laminar flow of effluent therethrough.

60. The process chamber of claim 59 wherein the exhaust tube comprises a cylinder having an axis parallel to the direction of the flow of the effluent through the exhaust tube.

61. The process chamber of claim 24 further comprising a reagent gas mixer to mix the reagent gas with the effluent.

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62. The process chamber of claim 24 wherein the sapphire comprises monocrystalline sapphire.

63. The process chamber of claim 24 further comprising an RF energy applicator to couple RF energy to the effluent.

64. The process chamber of claim 24 further comprising:  
(a) a gas analyzer adapted to monitor the hazardous gas content of the effluent in the exhaust tube and to provide a signal in relation to the hazardous gas content of the effluent; and  
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(b) a computer controller system comprising a computer readable medium having computer readable program code embodied therein, the computer controller system capable of monitoring the signal from the gas analyzer, and when the hazardous gas content of the effluent exceeds a safety level, performing at least one of:

(i) adjusting a power applied to the gas energizer to reduce the hazardous gas content in the effluent,  
(ii) adjusting process conditions in the process chamber to reduce the hazardous gas content in the effluent,  
(iii) activating an alarm or metering display,  
(iv) adding a reagent gas to the effluent before or after the effluent is energized, to reduce the hazardous gas content in the effluent, or  
(v) terminating the process being conducted in the process chamber.

65. The process chamber of claim 64 wherein the computer readable program code on the computer readable medium comprises one or more of:

(1) gas analyzer program code for receiving the signal from the gas analyzer, and storing or passing the signal to other program codes,  
(2) gas energizer program code for adjusting a power level of the microwave applicator in relation to the signal,  
(3) reagent gas program code for operating a reagent gas mixer that adds reagent gas to the effluent in relation to the signal, and  
(4) safety operational program code that upon receiving a signal that the hazardous gas content of the effluent exceeds a safety level, performs at least one of (1) adjusting process conditions in the process chamber to reduce the hazardous gas content, (2) operating an alarm, (3) providing a metering display that shows the level of the hazardous gas content, or (4) shutting down the process chamber.

66. The process chamber of claim 26 wherein the exhaust tube is substantially absent projections or recesses that alter the flow direction of the effluent through the exhaust tube.

67. The process chamber of claim 26 wherein the exhaust tube comprises a length that is sufficiently long to reduce the hazardous gas content of the effluent flowing through the exhaust tube without recirculating the effluent in the exhaust tube.

68. The process chamber of claim 26 wherein the exhaust tube comprises a length that is sufficiently long to provide a residence time of the effluent that is at least about 0.01 seconds.

69. The process chamber of claim 26 wherein the exhaust tube is adapted to provide a laminar flow of effluent therethrough.

70. The process chamber of claim 69 wherein the exhaust tube comprises a cylinder having an axis parallel to the direction of the flow of the effluent through the exhaust tube.

71. The process chamber of claim 26 further comprising a reagent gas mixer to mix the reagent gas with the effluent.

72. The process chamber of claim 26 wherein the sapphire comprises monocrystalline sapphire.

73. The process chamber of claim 26 further comprising an RF energy applicator to couple RF energy to the effluent.

74. The process chamber of claim 1 wherein the exhaust tube is adapted to provide a non-circuitous flow of effluent therethrough.

75. The apparatus of claim 10 wherein the exhaust tube is adapted to provide a non-circuitous flow of effluent therethrough.